

CLAIMS

1. An optometric apparatus which performs a subjective eye examination by prompting a subject to view test symbols
5 displayed on display means by one of the right and left eyes at a time and then obtaining a result of viewing by the subject. The optometric apparatus comprising:

astigmatic axis angle determination means for displaying test symbols for determining an astigmatic axis angle and then
10 obtaining a result of viewing by the subject to determine the astigmatic axis angle;

hyperopia and myopia determination means for displaying test symbols for determining hyperopia or myopia in two orthogonal orientations selected in accordance with the
15 astigmatic axis angle determined, and then obtaining a result of viewing by the subject to determine hyperopia or myopia at the astigmatic axis angle determined and at an angle orthogonal thereto; and

refractive power determination means for displaying test
20 symbols for determining a refractive power in two orthogonal orientations selected in accordance with the astigmatic axis angle determined, and then obtaining a result of viewing by the subject to determine refractive powers at the astigmatic axis angle determined and at an angle orthogonal thereto.

25 2. The optometric apparatus according to claim 1, wherein

the astigmatic axis angle determination means comprises: means for displaying an astigmatic axis determination chart which contains four test symbols each having multiple straight lines arranged in parallel at angles of about 45 degrees, about 90 degrees, about 135 degrees, and 180 degrees, respectively; means for prompting the subject to select any test symbol viewed with higher contrast in the astigmatic axis determination chart displayed; and means for determining an astigmatic axis angle in accordance with the test symbol selected in the astigmatic axis determination chart.

3. The optometric apparatus according to claim 1, wherein the astigmatic axis angle determination means includes: means for displaying a first astigmatic axis determination chart which contains four test symbols each having multiple straight lines arranged in parallel in four orientations at angles of about 45 degrees, about 90 degrees, about 135 degrees, and 180 degrees, respectively; means for prompting a subject to select any test symbol viewed with higher contrast in the first astigmatic axis determination chart displayed; means for displaying a second astigmatic axis determination chart which contains four test symbols each having multiple straight lines arranged in parallel in four orientations generally intermediate to the four orientations; means for prompting the subject to select any test symbol viewed with higher contrast in the second astigmatic axis determination chart displayed;

and means for determining an astigmatic axis angle in accordance with the test symbol selected in the first astigmatic axis determination chart and the test symbol selected in the second astigmatic axis determination chart.

5 4. The optometric apparatus according to claim 1, wherein the astigmatic axis angle determination means comprises: means for displaying a first astigmatic axis determination chart which contains four test symbols each having multiple straight lines arranged in parallel in four orientations at angles of
10 about 45 degrees, about 90 degrees, about 135 degrees, and 180 degrees, respectively; means for prompting a subject to select any test symbol viewed with higher contrast in the first astigmatic axis determination chart displayed; means for displaying a second astigmatic axis determination chart which
15 contains four test symbols each having multiple straight lines arranged in parallel in four orientations generally intermediate to the aforementioned four orientations; means for prompting the subject to select any test symbol viewed with higher contrast in the second astigmatic axis
20 determination chart displayed; means for displaying a third astigmatic axis determination chart which includes the test symbol selected by the subject in the first astigmatic axis determination chart and the test symbol selected by the subject in the second astigmatic axis determination chart;
25 means for prompting the subject to select any test symbol

viewed with higher contrast in the third astigmatic axis determination chart displayed; means for determining an astigmatic axis angle in accordance with the test symbol selected in the first astigmatic axis determination chart, the test symbol selected in the second astigmatic axis determination chart, and the test symbol selected in the third astigmatic axis determination chart.

5 5. The optometric apparatus according to any one of claims 1 to 4, wherein the hyperopia and myopia determination means comprises: means for displaying a first hyperopia and myopia determination chart having a red-based color background area and a blue-based color background area, in both the areas black-based color straight lines are drawn in one of the two selected orthogonal orientations; means for prompting the subject to select area which provides a clearer appearance of the straight lines to the subject in the first hyperopia and myopia determination chart displayed; means for displaying a second hyperopia and myopia determination chart having a red-based color background area and a blue-based color background area, in both the areas black-based color straight lines are drawn in the other of the two selected orthogonal orientations; means for prompting the subject to select area which provides a clearer appearance of the straight lines to the subject in the second hyperopia and myopia determination chart displayed; means for determining hyperopia and myopia at

the astigmatic axis angle determined and at an angle
orthogonal thereto in accordance with a result selected in the
first hyperopia and myopia determination chart and a result
selected in the second hyperopia and myopia determination
5 chart.

6. The optometric apparatus according to any one of
claims 1 to 4, wherein the hyperopia and myopia determination
means includes: means for displaying a first hyperopia and
myopia determination chart having a red-based color background
10 area and a blue-based color background area, in both the areas
black-based color straight lines are drawn in one of the two
selected orthogonal orientations; means for prompting the
subject to select area which provides a clearer appearance of
the straight lines to the subject in the first hyperopia and
15 myopia determination chart displayed; means for displaying a
second hyperopia and myopia determination chart having a red-
based color background area and a blue-based color background
area, in both the areas black-based color straight lines are
drawn in the other of the two selected orthogonal
20 orientations; means for prompting the subject to select area
which provides a clearer appearance of the straight lines to
the subject in the second hyperopia and myopia determination
chart displayed; means for displaying a third hyperopia and
myopia determination chart having a red-based color background
25 area in which black-based color straight lines are drawn in

the one of the two selected orthogonal orientations and a blue-based color background area in which black-based color straight lines are drawn in the other of the two selected orthogonal orientations; means for prompting the subject to select area which provides a clearer appearance of the straight lines to the subject in the third hyperopia and myopia determination chart displayed; means for displaying a fourth hyperopia and myopia determination chart having a red-based color background area in which black-based color straight lines are drawn in the other of the two selected orthogonal orientations and a blue-based color background area in which black-based color straight lines are drawn in the one of the two selected orthogonal orientations; means for prompting the subject to select area which provides a clearer appearance of the straight lines to the subject in the fourth hyperopia and myopia determination chart displayed; and means for determining hyperopia and myopia at the astigmatic axis angle determined and at an angle orthogonal thereto in accordance with a result selected in the first hyperopia and myopia determination chart, a result selected in the second hyperopia and myopia determination chart, a result selected in the third hyperopia and myopia determination chart, and a result selected in the fourth hyperopia and myopia determination chart.

7. The optometric apparatus according to claim 5 or 6,

wherein the hyperopia and myopia determination means includes the hyperopia and myopia determination chart in which the blue-based color area has a lower brightness than that of the red-based color area.

5 8. The optometric apparatus according to claim 7, wherein the hyperopia and myopia determination means limits the time of displaying each of the hyperopia and myopia determination charts.

 9. The optometric apparatus according to any one of
10 claims 1 to 8, wherein the refractive power determination means comprises: means for displaying a refractive power determination chart in which test symbols having a certain number of straight lines arranged in parallel in the two selected orthogonal orientations are varied in size in a
15 stepwise manner; means for prompting the subject to select the smallest viewable test symbol in the refractive power determination chart displayed; and means for determining refractive powers at the astigmatic axis angle determined and at an angle orthogonal thereto in accordance with the test
20 symbol selected in the refractive power determination chart.

 10. The optometric apparatus according to any one of claims 1 to 8, wherein the refractive power determination means comprises: means for sequentially displaying a plurality of refractive power determination charts which have a
25 combination of test symbols having a certain number of

straight lines drawn in parallel in the two selected
orthogonal orientations where the step difference of size is
two or more; means for prompting the subject to select the
smallest viewable test symbol in each of the refractive power
5 determination charts displayed; and means for determining
refractive powers at the astigmatic axis angle determined and
at an angle orthogonal thereto in accordance with the test
symbols selected in each of the refractive power determination
charts.

10 11. The optometric apparatus according to claim 9 or 10,
wherein the refractive power determination chart has side
zones, on both outside ends of a widthwise direction of the
certain number of straight lines drawn, the side zones having
a width 0.5 to 2.0 times the width of the straight lines and a
15 certain contrast against the straight lines.

12. The optometric apparatus according to claim 11,
wherein the side zones in the refractive power determination
chart are different in color from areas between the straight
lines and equal to or higher than the areas between the
20 straight lines in brightness.

13. The optometric apparatus according to claim 11,
wherein the refractive power determination chart has the
straight lines in a black-based color, the areas between the
straight lines in a green-based color, and the side zones in a
25 yellow-based color.

14. The optometric apparatus according to any one of claims 8 to 13, wherein the refractive power determination means comprises: far refractive power determination means for prompting the subject to view test symbols at a far distance from display means and select the smallest viewable test symbol; near refractive power determination means for prompting the subject to view test symbols at a close distance to the display means and select the smallest viewable test symbol; and means for determining the refractive powers at the astigmatic axis angle determined and at an angle orthogonal thereto in accordance with the test symbol selected in the far refractive power determination means and the test symbol selected in the near refractive power determination means.

15. The optometric apparatus according to claim 14, wherein the near refractive power determination means is performed on a subject whose determination is suspended in the hyperopia and myopia determination means, and on a subject at a predetermined age or older, determined to have hyperopia by the hyperopia and myopia determination means.

16. The optometric apparatus according to any one of claims 1 to 8, wherein the refractive power determination means comprises: means for displaying a refractive power determination chart having test symbols varied in size in a stepwise manner, each of the test symbols having a line group area with red-based color straight lines and blue-based color

straight lines of a uniform width drawn alternately in the two selected orthogonal orientations, and a reference color area of the same color as either one of the straight lines in the line group area; means for prompting the subject to select the
5 smallest test symbol in the refractive power determination chart displayed in which any straight lines in the line group area provide an appearance of the same color as that of the reference color area; and means for determining the refractive powers at the astigmatic axis angle determined and at an angle
10 orthogonal thereto in accordance with the test symbol selected in the refractive power determination chart.

17. The optometric apparatus according to any one of claims 1 to 8, wherein the refractive power determination means includes: means for sequentially displaying a plurality
15 of refractive power determination charts having a combination of test symbols having a line group area with red-based color straight lines and blue-based color straight lines of a uniform width drawn alternately in the two selected orthogonal orientations where the step of difference of size is two or
20 more, and a reference color area of the same color as either one of the straight lines in the line group area; means for prompting the subject to select the smallest test symbol in each of the refractive power determination charts displayed in which any straight lines in the line group area provide an
25 appearance of the same color as that of the reference color

area; and means for determining the refractive powers at the astigmatic axis angle determined and at an angle orthogonal thereto in accordance with the test symbol selected in each of the refractive power determination charts.

5 18. The optometric apparatus according to any one of claims 2 to 4, comprising: means for displaying a rough determination chart in which test symbols having no directivity are varied in size in a stepwise manner; means for prompting the subject to select the smallest viewable test
10 symbol in the rough determination chart displayed; and rough determination means for determining a subject's rough view, wherein

the astigmatic axis angle determination means has means for adjusting the size of each test symbol in each of the
15 astigmatic axis determination charts displayed in accordance with the rough view determined.

19. The optometric apparatus according to any one of claims 5 to 8, comprising: means for displaying a rough determination chart in which test symbols having no
20 directivity are varied in size in a stepwise manner; means for prompting the subject to select the smallest viewable test symbol in the rough determination chart displayed; and rough determination means for determining a subject's rough view, wherein the hyperopia and myopia determination means has means
25 for adjusting the width and intervals of the straight lines

drawn in each of the hyperopia and myopia determination charts displayed in accordance with the rough view determined.

20. The optometric apparatus according to any one of claims 8 to 16, comprising: means for displaying a rough
5 determination chart in which test symbols having no directivity are varied in size in a stepwise manner; means for prompting the subject to select the smallest viewable test symbol in the rough determination chart displayed; and rough determination means for determining a subject's rough view,
10 wherein the refractive power determination means has means for restricting the range of size of the test symbol in the refractive power determination chart displayed in accordance with the rough view determined.

21. The optometric apparatus according to any one of
15 claims 1 to 20, wherein in at least one of the astigmatic axis angle determination means, the hyperopia and myopia determination means, and the refractive power determination means, the subject is prompted to view a test symbol while being shielded not to let ambient light into the subject's eye.

20 22. The optometric apparatus according to any one of claims 1 to 21, comprising: optical eyeball model determination means for selecting a start eyeball model in accordance with the refractive power determined by the refractive power determination means and determining an
25 optical eyeball model by verifying the model for validity at a

given accommodation point of the subject; and lens power determination means for verifying the focusing capability provided when the subject wears eyeglasses or contact lenses using the optical eyeball model and determining the lens power.

5 23. An optometric method for performing a subjective eye examination by prompting a subject to view test symbols displayed on display means by one of the right and left eyes at a time and then obtaining a result of viewing by the subject, the method comprising the steps of:

10 displaying test symbols for determining an astigmatic axis angle and then obtaining a result of viewing by the subject to determine the astigmatic axis angle;

 displaying test symbols for determining hyperopia or myopia in two orthogonal orientations selected in accordance
15 with the astigmatic axis angle determined, and then obtaining a result of viewing by the subject to determine hyperopia or myopia at the astigmatic axis angle determined and at an angle orthogonal thereto; and

 displaying test symbols for determining a refractive
20 power in two orthogonal orientations selected in accordance with the astigmatic axis angle determined, and then obtaining a result of viewing by the subject to determine a refractive power at the astigmatic axis angle determined and at an angle orthogonal thereto.

25 24. The optometric method according to claim 23, wherein

the step of determining an astigmatic axis angle comprises the steps of: displaying a first astigmatic axis determination chart which contains four test symbols each having multiple straight lines arranged in parallel in four orientations at angles of about 45 degrees, about 90 degrees, about 135 degrees, and 180 degrees, respectively; prompting a subject to select any test symbol viewed with higher contrast in the first astigmatic axis determination chart displayed; displaying a second astigmatic axis determination chart which contains four test symbols each having multiple straight lines arranged in parallel in four orientations generally intermediate to the aforementioned four orientations; prompting the subject to select any test symbol viewed with higher contrast in the second astigmatic axis determination chart displayed; displaying a third astigmatic axis determination chart which includes the test symbol selected by the subject in the first astigmatic axis determination chart and the test symbol selected by the subject in the second astigmatic axis determination chart; prompting the subject to select any test symbol viewed with higher contrast in the third astigmatic axis determination chart displayed; and determining an astigmatic axis angle in accordance with the test symbol selected in the first astigmatic axis determination chart, the test symbol selected in the second astigmatic axis determination chart, and the test symbol

selected in the third astigmatic axis determination chart.

25. The optometric method according to claim 23 or 24,
wherein the step of determining hyperopia and myopia comprises
the steps of: displaying a first hyperopia and myopia
5 determination chart having a red-based color background area
and a blue-based color background area, in both the areas
black-based color straight lines are drawn in one of the two
selected orthogonal orientations; prompting the subject to
select area which provides a clearer appearance of the
10 straight lines to the subject in the first hyperopia and
myopia determination chart displayed; displaying a second
hyperopia and myopia determination chart having a red-based
color background area and a blue-based color background area,
in both the areas black-based color straight lines are drawn
15 in the other of the two selected orthogonal orientations;
prompting the subject to select area which provides a clearer
appearance of the straight lines to the subject in the second
hyperopia and myopia determination chart displayed; displaying
a third hyperopia and myopia determination chart having a red-
20 based color background area in which black-based color
straight lines are drawn in the one of the two selected
orthogonal orientations and a blue-based color background area
in which black-based color straight lines are drawn in the
other of the two selected orthogonal orientations in;
25 prompting the subject to select area which provides a clearer

appearance of the straight lines to the subject in the third hyperopia and myopia determination chart displayed; displaying a fourth hyperopia and myopia determination chart having a red-based color background area in which black-based color straight lines are drawn in the other of the two selected orthogonal orientations and a blue-based color background area in which black-based color straight lines are drawn in the one of the two selected orthogonal orientations; prompting the subject to select area which provides a clearer appearance of the straight lines to the subject in the fourth hyperopia and myopia determination chart displayed; and determining hyperopia and myopia at the astigmatic axis angle determined and at an angle orthogonal thereto in accordance with a result selected in the first hyperopia and myopia determination chart, a result selected in the second hyperopia and myopia determination chart, a result selected in the third hyperopia and myopia determination chart, and a result selected in the fourth hyperopia and myopia determination chart.

26. The optometric method according to any one of claims 23 to 25, wherein the step of determining a refractive power comprises the steps of: sequentially displaying a plurality of refractive power determination charts which have a combination of test symbols having a certain number of straight lines drawn in parallel in the two selected orthogonal orientations where the step difference of size is two or more; prompting

the subject to select the smallest viewable test symbol in each of the refractive power determination charts displayed; and determining refractive powers at the astigmatic axis angle determined and at an angle orthogonal thereto in accordance
5 with the test symbols selected in each of the refractive power determination charts.

27. The optometric method according to any one of claims 23 to 26, wherein the step of determining a refractive power comprises: a far refractive power determination step of
10 prompting the subject to view test symbols at a far distance from display means and select the smallest viewable test symbol; a near refractive power determination step of prompting the subject to view test symbols at a close distance to the display means and select the smallest viewable test
15 symbol; and a step of determining the refractive powers at the astigmatic axis angle determined and at an angle orthogonal thereto in accordance with the test symbol selected through the far refractive power determination step and the test symbol selected through the near refractive power
20 determination step.

28. The optometric method according to any one of claims 23 to 25, wherein the step of determining a refractive power comprises the steps of: displaying a refractive power determination chart having test symbols varied in size in a
25 stepwise manner, each of the test symbols having a line group

area with red-based color straight lines and blue-based color straight lines of a uniform width drawn alternately in the two selected orthogonal orientations, and a reference color area of the same color as either one of the straight lines in the line group area; prompting the subject to select the smallest test symbol in the refractive power determination chart displayed in which any straight lines in the line group area provide an appearance of the same color as that of the reference color area; and determining the refractive powers at the astigmatic axis angle determined and at an angle orthogonal thereto in accordance with the test symbol selected in the refractive power determination chart.

29. The optometric method according to any one of claims 23 to 25, wherein the step of determining a refractive power comprises the step of: sequentially displaying a plurality of refractive power determination charts having a combination of test symbols having a line group area with red-based color straight lines and blue-based color straight lines of a uniform width drawn alternately in the two selected orthogonal orientations where the step difference of size is two or more, and a reference color area of the same color as either one of the straight lines in the line group area; prompting the subject to select the smallest test symbol in each of the refractive power determination charts displayed in which any straight lines in the line group area provide an appearance of

the same color as that of the reference color area; and
determining the refractive powers at the astigmatic axis angle
determined and at an angle orthogonal thereto in accordance
with the test symbol selected in each of the refractive power
5 determination charts.

30. The optometric method according to any one of claims
23 to 29, comprising the steps of: displaying a rough
determination chart in which test symbols having no
directivity are varied in size in a stepwise manner; prompting
10 the subject to select the smallest viewable test symbol in the
rough determination chart displayed; and determining a
subject's rough view, wherein

the step of determining an astigmatic axis angle and/or
the step of determining hyperopia and myopia and/or the step
15 of determining a refractive power have a step of varying the
condition of the test symbol displayed in accordance with the
rough view determined.